UNIVERSITI PUTRA MALAYSIA

THE EFFECTS OF VARYING PROTEIN LEVELS ON THE GROWTH, SURVIVAL AND YIELD OF *PENAEUS INDICUS* UNDER IRANIAN CONDITION

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By

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Thesis Submitted in Partial Fulfilment of the Requirements for the Degree of Master of Science in the Faculty of Fisheries and Marine Science, Universiti Pertanian Malaysia

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Chairman Dr Che Roos Saad

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Four shrimp diets for *Penaus indicus* were formulated using available indigenous feed ingredients (fish meal, shrimp meal, soybean meal, wheat flour, corn flour and corn oil) using linear programming techniques All the diets were isocaloric (400 kcal/100g), containing 5 to 11 5% fat The dietary protein levels were 30, 35, 40 and 45% with an amino acid profile similar to that of the prawn The production costs of the diets were Rials 1140, Rials 1240, Rials 1340 ,Rials 1440 per kilogram respectively

Eighteen indoor concrete tanks (3 45 m^2 each) receiving flow-through seawater (42 ppt) of 2 l /sec were stocked with 138 *P.indicus* fry (0 014 g mean wt) at a stocking density of 40 shrimp per m^2 In the case of the pond, eighteen compartments (9 5 m^2 each) separated by nylon nets in pond were also prepared and stocked with 380 shrimps of the same size and stocking density as the tank experiment The shrimps were fed with the prepared diets and two commercial diets as a control for growth, feed and protein utilisation, and carcass composition during grow-out for 115 days Specific growth rate (SGR) was high for all diets with a mean ranging from 3 02 to 3 18 with the exception of a commercial feed (Chinah) which had a value of 0 81 There were no significant differences ($P> 0\ 05$) among

diets for growth rate, final length, fat and protein deposition in tanks and pond Significant differences ($P<0.05$) were observed in shrimp fed 40% protein diet for net profit, yield, survival rate and weight gain as compared to shrimp fed the other diets The results also indicate that shrimp *P.indicus* can be reared in sea water of high salinity from fry through marketable sizes more economically on an optimum dietary protein of 40%

Abstrk tesis yang dikemukakan kepada Senat Universiti Pertanian Malaysia sebagai memenuhi sebahagian dari keperluan untuk Ijazah Master Sains.

KESAN PENGGUNAAN PROTEIN YANG BERBEZA KE ATAS PERTUMBUHAN, KEMANDIRIAN DAN HASIL *PENAUS INDICUS* DI IRAN

Oleh

ABDUL HAMID YAZDANI JAHROMI

Julai 1995

Pengerusi: Dr. Che Roos Saad

Fakulti : Perikanan dan Sains Samudera

Empat makanan udang untuk *Penaus indicus* dirumus dengan bahan makanan asli yang mudah didapati (tepung kasar ikan, tepung kasar udang, tepung kasar kacang soya, tepung gandum, tepung jagung dan minyak jagung) dengan menggunakan kaedah pengaturcaraan linear. Semua makanan yang di sediakan adalah isokalorik (400 k cal/100g) dan mengandungi 5 hingga 11.5% lemak. Paras dieteri proteinnya ialah 30, 35, 40 dan 45% dengan profil asid amino sama seperti yang terdapat pada udang. Kos pengeluaran pemakanan tersebut adalah masing-masing 1140 Rial, 1240 Rial, 1340 Rial dan 1440 Rial per kilogram.

Lapan belas tangki konkrit dalam bangunan (3.45m^2 tiap satu) yang dipenuhi air laut dari (42ppt) dengan kadar pengaliran air 2 l /saat ditempatkan bersama 138 anak udang *P. indicus* (0.014g berat min) dengan kadar perlepasan 40 udang per meter persegi. Lapan belas ruang (9.5 m^2 tiap satu) dalam kolam yang dipisah dengan

jaring juga disediakan untuk menempatkan udang yang sama saiz dan kadar perlepasan seperti tangki di atas

Semasa 115 hari tempoh pembesaran, udang diberi makanan yang disediakan dan dua makanan komersil sebagai makanan kawalan untuk pertumbuhan, penggunaan makanan dan protein serta pembentukan karkas Kadar Pertumbuhan Spesifik (SGR) adalah tinggi bagi semua makanan dengan julat antara 3 02 hingga 3 18 kecuali makanan komersil (Chenah) yang bernilai 0 81 Tiada perbezaan nyata (P >0 05) di kalangan makanan untuk pertumbuhan , kadar panjang maksimum, endapan lemak dan protein dalam tangki serta kolam

Perbezaan yang nyata (P <0 05) dapat dilihat pada udang yang diberi makanan mengandungi 40% protein berbanding udang yang diberi makanan yang lain dalam memperolehi untung bersih, hasil, kadar kemandirian dan pertambahan berat badan Keputusan juga menunjukkan bahawa udang *P. indicus* boleh diternak secara besar-besaran daripada ferai sehingga besar dalam air laut yang tinggi kemasinannya serta lebih ekonomik dengan makanan yang mengandungi protein optimum 40% jika dibandingkan dengan makanan-makanan yang lain

CHAPTER I

INTRODUCTION

Background of the Study

Marine prawn is one of the most important high-value products in world trade. It is an important potential export item as well as foreign exchange earner in most of the Asian countries.

Prawn farming has seen rapid growth during the last decade The reason for this is essentially increasing demand for prawn worldwide, both in the developed and developing countries (Rosenberry, 1994), diminishing supplies and increasing costs of marine landings of fish and prawns. However, from 1984 to 1993, world prawn landings stabilized at around 1.7 million metric tones (live weight) and it is thought to be close to the maximum sustainable yield (FAO, 1990; Rosenberry, 1994).

The Indian white shrimp *Penaeus (Fenneropenaeus) indicus* (H. Milne Edwards, 1837) culture has been found to be economical and profitable in Indonesia, Vietnam, Thailand, India and Philippines (Motoh; Buri, 1985). The total production of cultured *P. indicus* was estimated to be 43980 mt live weight constituting more than 6% of world cultured shrimp production of 733000 mt in 1994 (Csavas, 1994).

The distribution of the Indian white prawns *P. indicus,* is extensive, ranging from the Indo-west Pacific, east and the southeast of Africa to south of China, New Guinea and north of Australia In nature, *P. indicus* is found at depths of 2 to 90 m with sand or mud bottom The maximum total length is 184 mm for the male and 228 mm for the female with a maximum carapace length of 56 mm (Holthuis, 1980)

P. indicus is also an important item in the fisheries of Madagascar, Mozambique, Tanzania, Kenya and Somalia In Kenya, it constitutes 75 to 90% of the catch (Brusher, 1976) Although the species is of minor importance in Yemen, the Persian Gulf and Pakistan (Tirmizi, 1969), it is the most important species in India (Johnson, 1967), especially in its inshore fishery (Kurian and Sebastian, 1976).

P. indicus is the most important species in the rice-field shrimp farming system of the Kerala coast of southwest India, as well as in Bangladesh, Thailand, Indonesia and the Philippines

Statement of the Problem

Increased demand for prawn will have to be met by from aquaculture which at present is estimated to contribute only about 10% of total world fish landings (INFOFISH, 1995).

P. indicus offers good potential for development as a cultured species in south of the Islamic Republic of Iran, because of the long coastline (2000 km) much of which is suitable for marine fish and shrimp culture. Three of the world's most commercially important shrimp species such as the banana shrimp, *Penaeus merguiensis,* the tiger prawn, *Penaeus semisulcatus,* and the Indian white shrimp, *P.*

indicus, are indigenous to the seas fringing the Iranian coastline (Persian Gulf and Oman sea). There is also a large expanse of flat, barren and saline land stretching along the southern coast of Iran which is unsuitable for agricultural purposes This part of Iran could be utilised for shrimp culture

In Iran the culture of *P. indicus* was started as a pilot project in the Kolahi station which is about 150 km east of Bandar Abass Here, yields of up to 22500 kg/ha were obtained This indicates that there is a good potential for the culture of *P. indicus* in Iran (Shilat Report, 1994)

About 1000 ha of coastal land in Iran is being developed for shrimp culture. The use of a nutritionally balanced diet will certainly improve shrimp production and increase profits. Feed is a major item in prawn farming constituting 55 to 65% of the total variable cost of production (Singh and Kamarudin, 1994, Hardman *et al*, 1991). Therefore the economic efficiency of a farm is sensitive to both the cost and nutritional quality of the feed Thus, feed quality and cost are directly related with an improvement in feed quality inevitably affecting feed cost Therefore, feed quality and costs are critical factors in determining the profitability of shrimp production (Akiyama and Dominily, 1989) In the absence of a full-fledged feed mill industry in Iran, much of the shrimp feeds are imported Thus the cost of production of shrimp feed is very high as the market is monopolized by foreign producers Therefore the Iranian Fisheries Company (Shilat 1994) is working towards incorporating locally available feed ingredients to formulate least-cost diets which will reduce the production cost while still maintaining the competitiveness of the local feed mill industry As a priority, a baseline nutritional study is to be undertaken with a view to

formulating a nutritionally balanced least-cost diet. Very few papers have been published on the use of local raw ingredients for shrimp feed in Iran and there is very little documented evidence on the nutrition of *P. indicus*. According to Akiyama et al. (1992), in genral approximately 40 essential nutrients are required by the shrimp.

Protein and lipid are the major organic materials in animal tissues constituting 65-75% of total biomass on a dry weight basis. Protein is continuously being consumed by shrimp for growth and normal metabolism while lipids are highly digestible sources of energy. Protein is a component of tissue, while lipids are carriers of fat-soluble vitamins (Akiyama and Dominily, 1989). The recommended protein and lipid levels in commercial shrimp feeds are shown in Table 1. The locally available ingredients in Iran is shown in Table 2.

Table 1

Recommended Protein and Lipid Levels in Commercial Shrimp Feeds

Size of shrimp (gm)	Protein level (%)	Lipid level(%)
0.5 - 3.0	40	7.0
3.0 - 15.0	38	6.5
15.0- 40.0	36	6.0

Source : Akiyama and Dominily (1989).

Table 2

The Locally Available Raw Feed Ingredients in Iran

Ingredient	Cost Rials/kg	Protein %	Lipid %	Energy kal/100g
Fish meal	850 000	60 000	6 000	4 020
Shrimp head meal	600 000	42 670	1 400	3 210
Soybean meal	640 000	46 800	1 670	4 630
Wheat flour	300 000	12 570	1 360	4 320
Maize meal	600 000	9 800	3 500	3 569
Barley meal	300 000	11 900	2 400	3 060
Industrial date	400 000	n a	n a	n a
Cotton-seed meal	300 000	42 000	2 000	2 550
Corn oil	2500 000	0 000	100 000	9 -9 65
Sunflower oil	2500 000	0 000	100 000	9 -9 8

Note 2700 Iranian Rials = US $1
n a = not available

Significance of the Study

The significance of the study is as follows

1 The increasing need to establish the dietary protein requirements of *P indicus* because there is very little published information on the dietary needs of this species

2 The growing need to expand the aquaculture base (extensive, semi-intensive, or intensive) of *P indicus* in Iran in the context of increasing fishing pressure in and around the Oman Sea and the Persian Gulf

3 The development of farm-made or commercial aquafeeds using mostly locally available agricultural and wastes products of agro-processing industries

4 The utilisation of locally available feed stuff to reduce production cost thus encourages *P.indicus* culture by professional and subsistence fishermen or the commercial enterprises

5 The abundance of *P indicus* fry in the wild and hatchery system requires that baseline nutritional studies to establish *P indicus* as a cultured species

6 The conducive physico-chemical parameters of the coastal waters seem to provide a suitable aquatic environment for the culture of *P indicus*

7 The increasing demand for *P. indicus* both within I R Iran and the neighboring gulf states because of its relatively low price

8 Extensive or intensive culture of *P indicus* offers good potential for the economic development of extensive wastelands or wetland along the coasts of I R Iran

9 *P indicus* is one of the dominant species of the marine landings in and around the coastal waters of Iran

10 Fast growth and tolerance to a wide range of salinity levels and temperature gives *P indicus* a relative advantage over other penaied species and makes it a natural choice for culture (Udayakumara and Ponniah, 1988, Shilat Report, 1994)

Objectives

The objectives of this study are as follows:

(i) To formulate a suitable diet for *Penaeus indicus* using locally available raw feed ingredients

(ii) To determine experimentally, the best growth response of *Penaeus indicus* fed on optimum least-cost feed using linear programming techniques (LINDO)

CHAPTER II

LITERATURE REVIEW

Though nutritional principles are similar for all animals, the quantity of required nutrients vary with species There are approximately 40 essential dietary nutrients required by fish and terrestrial animals (Akiyama *et al* , 1992, Lovell, 1989, Stickney, 1979) These essential nutrients are assumed to be similar for shrimp and would include amino acids, fatty acids, energy, vitamins and minerals

Protein Requirement for Fish

Sakaras *et al* (1987) found the optimal dietary protein levels for grow out of seabass to be about 45 to 50 % with the dietary protein demand being higher during the larval stages However they did not study the energy content for the fish Khan *et al* (1992) studied the optimal dietary protein requirement of *Mystus nemurus* cultured in tanks under semi -controlled environmental conditions in a recycling water system The experimental fish were fed with six variable diets containing 27, 32, 37, 42, 47, and 50% protein The fish were found to grow moderately when fed on a 42% protein diet which is the optimum feed The principal protein sources were fish and soybean meals

Yon and Fuji (1975) tested diets containing 30 , 40 , 50 , 60 , and 70% protein on red sea bream and found that a diet of 50 % protein resulted in the highest growth rate.

Protein and Energy Requirement for Penaeid Shrimps

Akiyama (1988) reported that *P. monodon* fed with diets containing up to 40% soybean meal achieved good survival rates and best growth. He carried out the experiment using five shrimp diets which were extruded at low temperature and which had similar protein with different soybean meal contents (20, 30, 40, and 50% of soybean meal).

Pascal and Tabbu (1980) observed that juvenile *P. monodon* gave the best yield when fed with a diet containing 35% defatted soybean meal and 16% Peruvian fish meal.

Xinzhang and Lie (1988) who worked on optimum nutritional contents in the compound diet of *Penaeus orientalis* with body-weights ranging from 2.87--3.44 g found that 4.0% crude fat, 44% protein, 26% carbohydrate, 4.5% crude fibre and 4.5%. calcium and phosphorus together with a 1:2 Ca/P ratio was the best combination. Crude fat content clearly has a restrictive effect on the transformation of protein while carbohydrate and crude fibre content have a limited effect. Under experimental conditions, the daily requirements of the nutritional composition of diet per kg *P. orientalis* are found to be as follows: protein 25.96 g, carbohydrate 15.34 g, crude fibre 2.66g, and crude fat 2.36 g. The daily feeding ratio was 5.9% of the body weight of *P. orientalis* (Xinzhang and Lie, 1988).